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AN ANALYSIS OF THE RELATIONSHIP BETWEEN FOUR SELECTED CHARACTERISTICS OF TEACHERS AND THE RESULTS OF THEIR STUDENTS IN THE FINAL EXAMINATIONS IN PHYSICS 30

by

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ABSTRACT

This study investigated the relationship between four selected measurable characteristics of Alberta teachers and the results of their students in the Physics 30 final examinations for the school year 1960-1961. The four measurable characteristics chosen for this study were: (1) the number of years of professional training beyond the grade twelve level, (2) the number of years of teaching experience, (3) the number of university courses taken in the field of physics, and (4) subject matter preference of the teachers.

The data regarding the four above mentioned characteristics of teachers were obtained from questionnaires sent to principals of schools in which Physics 30 was taught during the school year 1960-1961.

Data regarding the results of the students were obtained from the offical examination results of the Examinations Branch of the Department of Education. The students' marks were then transformed into new scores by a regression equation (Appendix C) to eliminate any differences which may have occurred due to differences in mental ability.

This study compared thirty city and 124 non-city teachers with respect to the four measurable characteristics,

and also made a comparison between 820 city and 675 non-city students relative to their marks on final examinations in Physics 30.

The method of analyzing the data involved the use of two statistical techniques, (1) chi-square, and (2) analysis of variance.

This study found significant differences between city teachers and non-city teachers. City teachers surpassed non-city teachers in the number of university courses taken in the field of physics, in their preference for the teaching of physics, and in the amount of professional training taken by teachers. A comparison of the two groups on the basis of the number of years of teaching experience showed no significant difference between the two groups.

This study also revealed very significant positive relationships between students' marks in Physics 30 and three of the teacher characteristics used. The three characteristics were: (1) the number of years of teaching experience, (2) teacher preference in the subject field, and (3) the number of university-level courses taken by the teacher. No significant difference was found between students' marks and the number of years of professional training of teachers.

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THE PROBLEM

I. INTRODUCTION TO THE PROBLEM

In their study of teacher effectiveness, Gage and Orleans stated that a review of research on teacher effectiveness since the turn of the century disclosed that a great amount of effort had been expanded in this area, and the outcome of the work done to date was not encouraging.[1] The need for this type of research was further strengthened by a statement that the quality of teachers was one of the most important factors in the success or failure in education.[2] It is no wonder, then, that in one form or another, the question, "What is a good teacher?" has troubled administrators, school boards, parents, and even teachers to a great extent.

The problem that faces us is to develop a set of criteria by which we can measure teacher competence. Teacher competence may be attributed to many factors, one of these being the personality of the teacher.

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[1]N. L. Gage, and J. S. Orleans, "Guiding Principles in the Study of Teacher Effectiveness," Journal of Teacher Education, 3:296-297, (December), 1952.

[2]Report of the Royal Commission on Education. (Edmonton: Government of Alberta, the Queen's Printer, 1959), p. 180.

Characteristics such as interest, tolerance, humor, initiative, and many others could have a tremendous impact upon student learning. Characteristics such as these are subjective and as a result, hard to measure.

We can accept measures of teacher behavior as criteria only when the behavior has been demonstrated to have relationships to pupil growth and achievement. We generally prefer objectively observed performance because of the advantages of objective measures. Objective measures are referred to as ones that can be recorded--for example, paper and pencil tests.[3] Klapper stated that teacher effectiveness can best be tested by means of an examination which the teacher constructs and which measures information which should be known to all students. This would indicate whether pupils were deficient or progressing.[4] Betts supported the above statements by proposing that the measurement of pupil achievement or change be the logical technique for measuring the productiveness of

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[3]A. S. Barr, et al. "Report of the Committee on the Criteria of Teacher Effectiveness Supplement," Review of Educational Research, XXIII (June, 1952), p. 244.

[4]P. Klapper, "Efficiency in Classroom Instruction-Its Cause and Test," Educational Review, XLVIII (1914), pp. 501-502.

teachers, and that one criterion for judging effectiveness of teaching be through changes in pupils, in the increase in achievement of pupils in subject matter knowledge.[5] In moving away still further from personal qualities in relation to teacher competence, Chandler and Petty listed several requisites which they felt had a bearing on the success of a teacher in a particular teaching position. Some of the major ones listed are: (1) instructional skill, (2) scholarship and professional preparation, (3) teaching experience, and (4) one's interest in his work and subjects taught.[6] Characteristics such as those mentioned above are not related to personality, but are factual, and as such can be readily measured. McCall and Krause corroborated the above statements by citing various practices tried for judging teachers for merit pay. Various practices were used but were found quite impractical, so a system was devised whereby merit pay was to be given in terms of training, years of service, and knowledge of subject matter.[7] This then seems to indicate that

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[5]G. L. Betts, "Philosophy of the Measurement of Teaching Ability," School Life, 17:168-169, (1932).

[6]B. J. Chandler and P. V. Petty, Personnel Management in School Administration, (New York: World Book Company), pp. 124-125.

[7]W. A. McCall, and G. R. Krause, "Measurement of Teacher Merit for Salary Purposes," Journal of Educational Research, 53:2 (October, 1959), p. 73.

teacher training and years of experience are important characteristics in teacher competence.

Once we have established certain criteria by which we are to measure teachers, we must also have criteria to measure competence. Such criteria may be hard to establish as they are bound up with the goals of education. We must measure these goals in terms of values determined by society and the assessment of ability to teach them.[8]

For the purpose of this study, the goal we are striving for need also be measured. Student marks on the Department of Education Examinations are valid measures of educational achievement.[9] Though this standard may not include all the values and purposes of education, it does consider a significant part of the values since the Department of Education sets standards in the form of curricula and they are accepted by the public generally.

The present study uses four measurable characteristics: (1) years of professional training, (2) years of teaching experience, (3) the number of university courses taken in the field of physics, and (4) subject preference of the teachers. The criterion used for

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[8]Gage and Orleans, op. cit.

[9]D. B. Black, "The Prediction of University Freshman Success Using Grade Nine Departmental Examination Scores," The Alberta Journal of Educational Research, Vol. V, No. 4, (December, 1959), p. 2.

measuring student achievement is the marks on the Physics 30 examinations as set by the Examinations Branch of the Department of Education for the school year 1960-1961.

II. STATEMENT OF THE PROBLEM

This study will investigate four measurable characteristics of teachers of Physics 30 in Alberta schools during the school term 1960-1961 and the relationship to the results of their students in the Physics 30 examinations for that school year. The following teacher characteristics are to be considered: (1) years of professional training, (2) years of teaching experience, (3) number of university content courses in physics, and (4) preference of subject field.

The Main Problem

Do any of the four characteristics of grade twelve Physics 30 teachers relate significantly to the students' results in the final examinations in Physics 30?

Minor Problem 1

Are there any significant differences in the above four characteristics between teachers in city school systems and teachers in the non-city school systems?

Minor Problem 2

Do city students surpass non-city students in their results in the Physics 30 final examinations?

III. NEED FOR THE STUDY

The quality of teachers is an important factor in the success of education, and it seems logical, therefore, that school administrators would be anxious to know whether or not certain teacher characteristics are related to effective teaching. Since research, as previously mentioned, has not contributed too much in this field, the relationship of the four characteristics mentioned to the final examination marks in Physics 30 may be a significant step in teacher selection. This would answer many of the questions that school boards ask--who should be hired, and what criteria should be used for pay differentials? Merit ratings, which have been a point of contention between school boards and teachers for so long, may be less of a problem. The teacher training institutions would be able to answer the age old debate of more subject matter content versus more training and methodology. Principals and superintendents would have a sounder basis for the placement of teachers. Parents would feel satisfied that their children

were receiving the best instruction in their particular field. All of these questions await a suitable evaluation of the teacher.

Two parallel studies have more recently been completed by Lindstedt[10] and Wasylyk[11], both related to the field of mathematics. The findings of these studies, together with the ones previously mentioned should contribute to a better understanding of teacher characteristics relating to students' achievement.

IV. PROCEDURE

The study on the four selected measurable characteristics of teachers and their effects on students' performance on final examinations began initially with an examination of the Form A cards to discover which schools in the province were offering Physics 30 for the school year 1960-1961. The Form A cards were forms sent to the

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[10] S. A. Lindstedt, "Teacher Qualifications and Grade Nine Mathematics Achievement," (Master's thesis, The University of Alberta, Edmonton, Alberta, 1960.)

[11] E. Wasylyk, "Teacher Characteristics and Grade Twelve Mathematics Achievement,"(Master's thesis, The University of Alberta, Edmonton, Alberta, 1961.)

principals of schools to be filled in by principals regarding the organization of their particular school for that year. These forms included the courses taught, the number of pupils enroled in each course, and the names of the teachers offering instruction in the courses. A copy of Form A appears in Appendix D of this study.

When the schools offering physics were determined from the Form A cards, a questionnaire (a copy appears in Appendix A of this study) was sent to the principals of these schools to determine the number of years of teaching experience, the number of university courses, the number of years of teacher education, and the teaching preference of physics teachers of that particular school for the year 1960-1961. Since teacher competence was to be judged on the basis of students' marks, it was necessary to match students with their respective teachers. This was done by examining the official records of the Examinations Branch of the Department of Education where a record of students' marks on June examinations for each school was kept. From these records the students' marks were matched with their respective schools. Since this study took into consideration the mental ability of the students, it was necessary to obtain the results of a standardized test given to the students of the province under the

same conditions. An ability test had been given to all Grade IX students in June of 1958 by the Examinations Branch as part of their final examinations for that year. Records of these tests were also found in the Department of Education. The percentile scores on this test were then matched with the respective students thus providing the writer with the students' marks on the final examination in Physics 30, the students' mental ability, and the students matched with their respective teachers. The transformation of the students' marks on the examinations is discussed later under "Transformation of Scores."

V. BASIC ASSUMPTIONS

This study is based on the assumption that:

(1) Percentile scores on the Grade IX General Test are a valid measure of mental ability.

(2) The teacher characteristics selected are important.

(3) Students' marks on the Departmental Examinations are valid measures of educational achievement.

(4) Students' achievement in physics is a result of good teaching and not the result of non-teacher directed learning.

VI. DEFINITION OF TERMS

The following terms are defined as they are to be used in this study.

Teacher of a city school system: a teacher who answered the questionnaire as having taught in a city school in this province. To be classed as a city, there must be a population of at least 10,000.

Teacher of a non-city school system: a teacher teaching in a school other than a city school.

Examination marks: marks which the students received on the final examinations from the Examinations Branch of the Department of Education.

Students' scores or results: examination results which have been transposed into new scores by the use of the regression formula.

Percentile scores: these are the percentile scores recorded from the Grade IX ability test given in 1958.

Professional training: refers to the number of years of university education the teacher has completed.

University-level courses: courses in the physical sciences taken at a university.

Physics teachers: teachers of Alberta schools who taught Physics 30 during the school term 1960-1961.

VII. STATEMENT OF HYPOTHESIS

This study proposes to test the following hypotheses.

1. There are significant differences between city teachers and non-city teachers in:

(a) The number of university-level courses taken by each group.

(b) The number of years of professional training beyond the Grade XII level.

(c) The number of years of teaching experience.

(d) Teacher preference in subject-area taught.

2. There is a significant difference in the Physics 30 marks of city students and non-city students.

3. There are significant differences in students' marks when related to:

(a) The number of university-level physics courses a teacher holds.

(b) The number of years of professional training.

(c) The number of years of teaching experience.

(d) Teacher preference of subject-area taught.

VIII. DELIMITATIONS OF THE STUDY

1. This study is delimited to teachers of Alberta who were registered on the Form A cards with the Department of Education as teachers of Physics 30 for the school year 1960-1961.

2. This study is further delimited to the teachers of public and separate schools in the province of Alberta excluding teachers in private schools.

3. This study is also delimited to students who had written their Physics 30 examinations in 1960-1961, and who also had written their grade nine examinations in the province of Alberta in June 1958, and whose percentile ranks are recorded on the grade nine summary sheets in the Department of Education.

4. This study is delimited to the teachers who have answered the questionnaire sent to them by the writer.

5. This study includes only schools in which the students could be associated with their respective teachers. One school had to be omitted from the study as the students and teacher could not be matched.

CHAPTER II

REVIEW OF RELATED LITERATURE

I. SCOPE OF THE REVIEW

Extensive research has been carried on in the field of teacher competence in an attempt to establish measures of teachers' ability. Domas and Tiedman have listed many studies carried out in this field.[1] There are many factors which affect teacher effectiveness in their attempt to achieve some of the goals of education. Gage and Orleans stated that it would be very difficult to measure teacher effectiveness in terms of the general goals of education as goals will vary with different subject areas. They concluded that if teacher competence were to be measured, it must then be measured in terms of specific goals.[2]

This study will be delimited to research and related literature associated with the criteria on teacher competence based on the number of years of teaching experience, the number of years of professional training, the number of university content courses in the

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[1]S. J. Domas, and D. V. Tiedman, "Teacher Competence: An Annotated Bibliography," Journal of Experimental Education, 19:103-218, (December), 1950.

[2]N. L. Gage, and J. S. Orleans, op. cit., pp. 297-298.

field of physics, and teachers' subject-area preference. The criterion used to measure the specific goal considered in this study will be students' marks on the provincial examinations in Physics 30.

II. EXPERIENCE

The importance of teaching experience in relation to teacher effectiveness has long been a point of discussion among leading educators as well as laymen. The following studies provide considerable information on the role experience plays in teacher effectiveness. Ackerman stated that apparently, the teacher with the greater experience was the one most likely to succeed.[3] Whether valid or not, administrators of school systems throughout the country use teaching experience as a guide in the selection and promotion of teachers. In a test given to students in chemistry, Rolfe found that highest scores were reported for pupils of instructors who had one to eleven years of teaching experience, and a notable decrease was seen for instructors with twelve or more years of teaching experience.[4] Moss, Lamon and Hunt in a

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[3]W. I. Ackerman, "Teacher Competence and Pupil Change," Harvard Educational Review, 24:273, fall, 1954.

[4]J. F. Rolfe, "The Measurement of Teaching Ability: Study No. 2," Journal of Experimental Education, 14:64, 1945.

study of students of chemistry who were equated in class size, average intelligence, and previous training also found a decrease in median scores among students whose instructors had twelve or more years of experience.[5] This study seems to corroborate the study made by Rolfe.

Schunert found the following factors concerning the teachers of Algebra to be significantly associated with student achievement. Classes taught by teachers who had more than eight years teaching experience exceeded the achievement of classes taught by teachers who had less experience. He found no significant difference between the achievement of classes taught by teachers of less than two years experience and the achievement by teachers having from two to eight years of experience.[6]

In a study of pupils' competence in mathematics, Alkire found that a teacher's T-Score (which takes into consideration both teaching experience and training in

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[5]F. A. Moss, W. M. Lamon, and T. Hunt, "Impersonal Measurement of Teaching," Educational Record, 10:40-50, 1929.

[6]J. Schunert, "The Association of Mathematical Achievement with Certain Factors Resident in the Teacher, in the Teaching, and in the Pupil, and in the School," Journal of Experimental Education, 19:233, March, 1951.

higher mathematics) showed a positive correlation with pupils' competence in mathematics.[7]

Wasylyk, in his study of the relationship between teacher experience and Mathematics 30 results found that there was no significant difference in student examination results between teachers with nine or less years of teaching experience and teachers with ten to nineteen years of teaching experience. He also found that there was no significant difference in student results between teachers with thirty-five years of experience and teachers of nine or less years of experience. Teachers with ten to nineteen years of experience produced better results than teachers with thirty-five or more years of experience. The results of teachers with twenty to thirty-four years of experience are better than those of any group.[8]

McCall and Krause in a study on overall growth of pupils found that with one or two years of teaching

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[7]G. D. Alkire, Functional Competence in Mathematics," Journal of Experimental Education, 22:227-236, March, 1954.

[8]E. Wasylyk, "Teacher Characteristics and Grade Twelve Mathematics Achievement," (Master's thesis, The University of Alberta, Edmonton, Alberta, 1961.) p. 47.

experience teachers averaged higher criterion scores on overall growth than did other teachers.[9]

Lindstedt, in his study of the competence of grade nine mathematics teachers in Alberta found that a significant relationship existed between student achievement and teaching experience. Teachers with five to nine years of teaching experience were more effective than teachers with three to four years of experience; but there was no difference in competence between teachers with five to nine years of experience and teachers with less than three years of experience. Students whose teachers had ten or more years of teaching experience obtained higher marks on the Grade IX Mathematics examinations than students whose teachers had less than ten years of teaching experience.[10]

When Lindstedt further investigated the relationship when both training and experience were used together, he found that increases in both training and experience were accompanied by improvement in student marks.[11]

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[9]W. A. McCall and G. R. Krause, "Measurement of Teacher Merit for Salary Purposes," Journal of Educational Research, 53:2 (October, 1951), p. 61.

[10]S. A. Lindstedt, "Teacher Qualifications and Grade Nine Mathematics Achievement," (Master's thesis, The University of Alberta, Edmonton, Alberta, 1960). p. 51.

[11]Ibid.

Studies by Stephens and Lichtenstein on teachers of grade five arithmetic showed a slight correlation of pupil growth with respect to teaching experience.[12]

Davis, in a study of 796 teachers and approximately 13,000 students to determine the effects of specialized training and teaching experience on the success of getting pupils through the Minnesota State Board Tests of Pupil Achievement, found that students of teachers with two or more years of experience were more successful in passing the tests than were students of teachers with one year of experience.[13]

In a study of fifty-four teachers and 1,214 pupils to determine whether more gain could be made under the tutelage of a trained, experienced and reputedly superior teacher than would be in the case if he were a novice, Betts carried out two tests. The first test was administered to the two contrasting groups of teachers--novices and experienced. These teachers rated themselves on a number of variables thought to be essential to teaching success. The experienced teachers scored higher than

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[12]J. M. Stephens and A. Lichtenstein, "Factors Associated with Success in Teaching Grade Five Arithmetic," Journal of Educational Research, 40:685-693, (May, 1947).

[13]H. M. Davis, The Use of State High School Examinations as an Instrument of Judging the Work of Teachers, (Teachers College Contribution to Education, No. 611, New York, Columbia University, 1934), p. 101.

novices. The test was administered a second time and the criterion of teaching ability was scores on achievement tests. Highly significant changes were seen in pupils of more experienced teachers.[14]

Most of the studies reviewed here seem to indicate that there is a significant relationship between student achievement and teaching experience, but there seems to be very little consistency as to the number of years of teaching experience which produces the best results in student performance.

III. THE ROLE OF TEACHER TRAINING, SUBJECT PREFERENCE, AND NUMBER OF UNIVERSITY COURSES HELD

The number of years of teacher training, the amount of preparation in a subject field, and teacher preference in teaching in a certain subject field are taking a prominent place in the field of educational research. The Royal Commission on Education recommends that all teachers have a minimum of four years of university training including a degree.[15]

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[14]G. L. Betts, "Pupil Achievement and the N. S. Trait in Teachers," Helen Walker, Ed., The Measurement of Teaching Efficiency, (New York: MacMillan Co., 1935), pp. 143-237.

[15]Report of the Royal Commission on Education, (Edmonton: Government of Alberta, The Queen's Printer, 1959), p. 187.

Hodgdon, in his report "Merit System for Teachers" expressed the hope that the level of teaching could be raised by raising certification requirements.[16] These reports seem to point to the fact that the amount of teacher training is an important factor in the whole process of education.

McCuskey gave several characteristics of a good teacher. One of these was being skilled in the theory and practice of his specialty.[17] This as well seemed to indicate that professional competence as well as concern for what a teacher would like to teach are relatively important in education. The importance of these characteristics is further corroborated by Eliassen, who reviewed 193 articles on desirable teacher qualifications and found that the teacher's knowledge of subject matter was fourth highest in frequency of mention and rank.[18] Now that we have seen that there is some concern for teacher training

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[16]D. R. Hodgdon, "Merit System for Teachers," Clearing House, 22:503-504, 1948.

[17]D. McCuskey, "How do you Know a Good Teacher?," Educational Digest, 13:14-16, (January, 1948).

[18]R. H. Eliassen and R. L. Martin, "Teacher Recruitment and Selection 1944-1947," Journal of Educational Research, 41:642, (1948).

and teacher preference, what has research got to offer us on their relationship to pupil progress?

Davis, in his investigation into the relationship between the training of high school teachers and pupil achievement reported that students of teachers who had no specialized training in subjects they taught scored higher on achievement tests than students of teachers who had received specialized training. One major exception was found in the field of chemistry.[19] This study would have drastic effects upon certain faculties of the university who feel that the study of specialized subjects improves one's ability to teach. We find much the same type of conclusions drawn by Lindstedt in his study on grade nine mathematics. He found that no significant difference was found in the grade nine results in mathematics for teachers having from one to four years of training, but his study revealed that teachers with more than four years of training were more effective.[20] Lindstedt also found that the number of university courses taken in mathematics does not reflect any significant differences in the effectiveness of Grade IX Mathematics teachers when the effectiveness

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[19]Davis, loc. cit.

[20]Lindstedt, op. cit., p. 35.

is measured by the results of the final examinations in Grade IX Mathematics.[21]

In a comparative study of examination results in Grade IX and Grade XII in one town school and three rural centralized schools, Bodnaruk found that even though town teachers had more experience and were more often teaching in specific fields in which they were trained, the difference in academic achievement of the two groups of students was not significant. Barring other factors, this study would indicate that years of experience, and specialized training in specific fields have no bearing on student achievement.[22] There were, however, two factors in this study which could probably have made a difference in the results if they had been taken into consideration. The above mentioned study did not take into consideration the mental ability of the two student groups, and the study used stanines as units of measure. The stanine as a unit of measure could probably be too large to notice slight but significant changes, and since the stanines were grouped, this made the categories still larger.

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[21] Ibid., p. 43.

[22] W. A. Bodnaruk, "A Comparative Study of Examination Results in Grade IX and Grade XII in One Town School and Three Rural Centralized Schools in the County of Ponoka," (Master's thesis, The University of Alberta, 1962), p. 103.

Although the above studies may not be too encouraging to educators, the results of the following studies prove to be more favorable with respect to specialized training, years of professional training and teacher preference. Hughes, in an early study of pupils in physics classes found that pupils of teachers with specialized training in physics scored higher than pupils of teachers who had no specialized training in physics.[23] These results lead to the conclusion that perhaps in certain highly technical areas the training of the teacher in his subject area is a matter of great importance.

As early as 1912, studies by Boyce showed that college or university work, or professional training, were important in high school teaching. He concluded that experience was important, but not as necessary as sometimes thought.[24]

In 1924, Rogers, in a study of the Monroe Silent Reading Tests given to pupils of grade three, four, and

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[23]J. M. Hughes, "A Study of Intelligence and of Training of Teachers Factors Conditioning Achievement of Pupils," School Review, 33:197-200, 1925.

[24]A. C. Boyce, "Qualities of Merit in Secondary School Teachers," Journal of Educational Psychology, 3:144-157, 1912.

five, reported that higher reading comprehension scores were generally accompanied by more teacher training of the teachers.[25]

In an attempt to discover those qualities of teachers that were related to different degrees of students' achievement, Cheydleur compiled data on 5,300 students. Measures of students' change were drawn from grades on examinations at the end of the introductory course in French. He reports that students of teachers with more professional training scored better than did students of instructors of lower rank.[26]

In a more recent study on the relationship between four measurable characteristics and the results of Mathematics 30 students in their final examinations, Wasylyk found that there was a strong relation between Mathematics 30 results and the academic and professional training of the teachers. There was some difference in examination results between students whose teachers have had less than four years of academic and professional training and

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[25]D. C. Rogers, "The Effect of Experience and Training on Improvement in Silent Reading Comprehension," Chicago Schools Journal, 6:329-331, May, 1924, cited by H. Walker, ed., The Measurement of Teaching Efficiency, New York: The MacMillan Company, 1935, p. 146.

[26]F. D. Cheydleur, "Judging Teachers of Basic French Courses by Objective Means at the University of Wisconsin 1919-1943," Journal of Educational Research, 39:161-192, 1946.

students whose teachers have had four but less than five complete years of training. The students' achievement of teachers with five but less than six years of training is very much higher than that of teachers with less than four years of training. However, the achievement of teachers with five but less than six years of training was not very much higher than that of teachers with four but less than five years of training. The students' achievement of teachers with six or more years of training far surpassed that of every other group of teachers. This study also showed that the results in the Mathematics 30 examinations were significantly improved when the teachers' background in university mathematics was increased.[27]

In a study similar to the present study, W. P. Eddy examined the relationship between certain teacher characteristics and Grade IX Social Studies achievement. His study found significant positive relationships between Grade IX Social Studies results and the following: (1) the number of years of professional training of teachers, (2) the number of university-level social studies courses taken, (3) the number of years of teaching experience, and (4) the subject-area preference of

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[27]E. Wasylyk, op. cit., pp. 40-44.

teachers. He also found that city students exceeded non-city students in their results on the final examinations in Social Studies IX.[28]

Bining stated that knowledge must extend beyond the immediate subject matter one teaches. A teacher requires a broad background in the subject he teaches.[29] In support of Bining's study, Randall, in a study based on the training of teachers for social studies instruction, recommended that a teacher be required to select courses related to the field of social studies. She further stated that the background of knowledge in the specific field that a teacher engaged in lies like a carpet beneath one's planning in terms of objectives, planning, and learning outcomes. She recommended that some means be sought to make a teacher aware of the value of university-level courses.[30]

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[28]W. P. Eddy, "Teacher Characteristics and Grade IX Social Studies Achievement," (unpublished Master's thesis, University of Alberta, 1961).

[29]A. C. Bining, and D. H. Bining, Teaching the Social Studies in Secondary Schools, New York: McGraw-Hill, 1952.

[30]R. E. Randall, "The Training of Teachers for Social Studies Instruction," (Master's thesis, University of Alberta, August 12, 1963).

SUMMARY

A review of the literature on the four selected measurable characteristics used in this study showed that there was very little consistency among the findings. The studies on the relationship between the number of years of teaching experience and students' marks were divided on the issue, but the majority of the studies found a positive relationship between the two. These studies, however, failed to agree on the best range in the number of years of teaching experience. Studies on the number of years of professional training were also divided as to the value of professional training upon student achievement. One of the more recent studies on mathematics found that the relationship between professional training and students' marks was very significant. This type of inconsistency was found throughout the studies and would lead us to believe that more research should be carried on in the field of teacher competence.

CHAPTER III

SOURCES, ORGANIZATION OF DATA, AND METHOD OF ANALYSIS

This chapter is divided into four major headings which will discuss the methods used to gather and analyze data on the teachers, the students, and the method used to interpret their interaction. The four headings are: (1) data on teachers, (2) data on students, (3) the transformation of scores, and (4) the method of analysis.

I. DATA ON TEACHERS

The basic source of information on the four measurable characteristics of teachers as discussed in this study was the questionnaire sent to principals of schools to be filled in by the physics teachers for the school year 1960-1961. In the event that the physics teacher had left the school system by the time the questionnaire arrived, the principal of the school was asked to complete the questionnaire from his personal files. Only one case occurred in which the principal of the school had to fill out the questionnaire regarding the physics teacher of his school without complete information regarding the number

of his university courses held in the field of physics. He felt reasonably sure, however, that the teacher had not taken any more than two courses. The items used for identifying the teachers with the four measurable characteristics are found in Appendix A of this study.

Early in the school year, the Department of Education required that principals report on the organization of their school for that school year. This information was recorded on the Form A card. The writer used the information from these cards to determine which schools offered Physics 30 during the school year 1960-1961, and to identify the Physics 30 teachers with their respective schools. The Form A cards revealed that there were one hundred sixty schools (Public and Separate) offering Physics 30 in the province of Alberta during the school year 1960-1961. One hundred twenty-nine of these were non-city schools, and the remaining thirty-one were city schools. Of the one hundred twenty-nine non-city schools, one hundred twenty-seven or 98.4 per cent replied to the questionnaire. Of the thirty-one city schools contacted, twenty-nine or 93.6 per cent returned the questionnaires. Of the total number of schools to which questionnaires were sent, 97.5 per cent answered. In all non-city school

systems, the number of teachers corresponded to the number of schools, and as a result, the percentage of teachers that answered the questionnaire was the same as the percentage of schools that answered. Of the thirty-one school systems offering Physics 30, thirty-seven teachers were reported engaged in the teaching of physics. Of the thirty-seven teachers, questionnaires were received on thirty-four or 91.9 per cent of these. Three of the thirty-four were not considered in this study as students and teachers could not be matched. This left thirty-one city school teachers to be considered in this study. Of the total number of teachers in both city and non-city school systems, ninety-seven per cent answered to the questionnaire.

Of the one hundred sixty-one teachers who replied to the questionnaires, 78.9 per cent were non-city teachers, and 21.1 per cent were teachers of city school systems.

II. DATA ON STUDENTS

The total number of students involved in this study was 1,495; 675 or 45.1 per cent were non-city students, and 820 or 54.9 per cent were city students.

The students' marks on the 1961 June final examinations in Physics 30 were derived from the records of the Examinations Branch of the Department of Education. These records were also used for the identification of the students with their respective teachers. Wherever there was only one teacher of Physics 30 in a particular school, there was no problem in identifying the student with his teacher. This was the case in all non-city schools. In some city schools where more than one teacher taught physics, the problem of identification was more difficult. Five such schools existed, four of which had two teachers and one of which had three teachers. Every effort was made to identify the students with their respective teachers. This was done by checking students' names recorded in the summary of Grade XII results from the Examinations Branch of the Department of Education with school files. This was not too difficult as only four schools of this type existed. In one instance a school had to be left out as proper identification could not be made.

The number of students registered on the Form A cards and the number of students who actually wrote the final examinations for the particular schools did not correspond. This was probably due to students who dropped out of school or who transferred to other schools.

Since this study takes into consideration the mental ability of the students, it was necessary to get information on this characteristic of the student population. This information was obtained from the Department of Education which had a record of the students' performance on mental ability tests given to students in Grade IX. This test was given as part of the Departmental Examinations in June of 1958, and the results were recorded in the form of a verbal score, a quantitative score, and a percentile rank on the whole test. The record of the percentile rank on the Grade IX final examinations was used in transforming the Physics 30 marks by the use of a regression equation.

There were many students for whom marks on both the 1961 Physics 30 examination and the 1958 Grade IX Departmental Examination could not be found. This reduced the population with usable marks to 1,495 students. Since the usable student population was considerably smaller than

the original Physics 30 population, it was considered advisable to test the representativeness of the groups used. The three groups tested for representativeness were: (1) the total sample of Physics 30 students, (2) the sample of non-city students, and (3) the sample of city students used in this study. The chi-square test on each group showed no significant difference between the sample groups used, and the total Physics 30 student population. The tables for the tests of representativeness of the groups used are found in Appendix B of this study.

III. TRANSFORMATION OF SCORES

The scholastic ability of students enroled in Physics 30 will vary to a great degree from school system to school system. Not only do they differ among the various school systems, but there is a variation within school systems where more than one teacher is involved in the teaching of physics. This variation may be due to several reasons. In school systems where more than one teacher is a teacher of physics, the classes may be divided on the basis of mental ability. To judge a teacher on the basis of students' results without taking the ability of a student into consideration would be most unfair. The variation among school systems may be due to

the method of selection. Since the prerequisites to Physics 30 were certain non-departmental courses in grade eleven, there was no uniform standard set as a pass mark, and as a result there was the possibility that the passing of students into Physics 30 varied greatly from school system to school system depending on the standards set by the teachers. Black stated that small high schools generally tended to overrate their students, but not all small schools did so.[1] The number of students enroled in Physics 30 in comparison to English 30 and Social Studies 30 was approximately one-third. This difference in enrolment could be attributed to several reasons, some of which may be that: (1) English 30 and Social Studies 30 were compulsory subjects for Grade XII matriculants, whereas Physics 30 was only required by certain faculties of our university, (2) girls showed less interest in physics than did boys and, as a result, registered in options other than physics, and (3) physics was a highly specialized science taken by students who had an aptitude for this type of work. However, there was some indication that screening,

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[1]D. B. Black, "Final Marks in Alberta Senior High Schools," The Alberta Journal of Educational Research, September, 1960, 6:3, p. 150.

or careful selection of students, was made by teachers for entry into Physics 30. This lack of uniformity in the prerequisites to Physics 30 and the effects of "screening" indicated that there was a considerable degree of difference in ability among students of various school systems.

The method used to transform the students' marks on the final examinations in Physics 30 into new scores (scores which take mental ability into consideration) was a correlation table of students' marks on the Physics 30 examination and the percentile scores of the students on the mental ability tests taken by them on the 1958 Grade IX final examinations. From the correlation table a regression formula was derived to transform examination scores into new scores used in all tables of this study. These new scores were considered to be scores which represented the students' achievement in relation to their mental ability. The method used to transform the scores will be found in Appendix C of this study.

IV. METHOD OF ANALYSIS

To analyze the data in the minor problems, the statistical method chi-square was used. This was done by casting the data into contingency tables and the probability value of "p" was determined in each case.[2] If the value of "p" were greater than .05, it indicated that there was no significant difference between the groups compared. A value of "p" which was less than .01 indicated that there was a great difference between the groups compared. For the purposes of this study a value of "p" between the .05 and .01 levels of confidence was considered significant enough to predict a difference between the variables measured.

In the major problems of this study, a one-way analysis of variance to determine the differences between means was used in addition to the preliminary use of chi-square. Whenever a significant F value has been found from the application of the analysis of variance to a single classification containing more than two categories, tests of significance of the differences between specific

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[2] J. P. Guilford, Fundamental Statistics, (New York: McGraw-Hill Book Company, 1956), pp. 228-239.

pairs of sub-groups may be desired. These tests may be accomplished by computing "t" values between any two means.[3]

The assumptions underlying the analysis of variance will be found in Appendix E of this study.

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[3] J. E. Wert, E. O. Neidt, and J. S. Ahmann, Statistical Methods in Educational and Psychological Research, (New York: Appleton-Century-Crofts, Inc., 1954, p. 183.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

This study investigated, as its major problem, the relationship of students' marks on the final examinations in Physics 30 to the four selected characteristics of teachers stated above. One thousand four hundred ninety-five students, and one hundred fifty-four teachers were used as the population for this study.

In the minor problem under study, relationships were determined between city teachers and non-city teachers with respect to the four selected characteristics of teachers, namely: (1) the number of years of professional training, (2) the number of university courses in the field of physics, (3) the number of years of teaching experience, and (4) teachers' subject-area preference. Also as part of the minor problem, city students were compared to non-city students relative to their results in the Physics 30 examinations.

I. MINOR PROBLEMS

Differences Between City Teachers and Non-City Teachers Relative to the Four Selected Characteristics

Tables I to V on the following pages analyze data related to the minor problems. Since all questions on the questionnaire were answered by all the teachers considered in the study, the number of teachers in each table is the same. The vertical divisions of each table are divided into two categories--city and non-city, while the horizontal divisions deal with the four measurable teacher characteristics. The data are set up in the form of contingency tables and then analyzed by the use of chi-square.

Differences Relative to the Number of Years of Professional Training

Table I compares city teachers and non-city teachers with respect to the number of years of professional training beyond the high school level.

Since the value of "p" lies between the .02 and .05 levels of confidence, the chi-square test of independence indicated that there was a significant difference between

the two groups compared. City teachers surpassed non-city teachers in the number of years of professional training.

TABLE I

CITY TEACHERS COMPARED WITH NON-CITY TEACHERS RELATIVE TO THE NUMBER OF YEARS OF PROFESSIONAL TRAINING

	Number of Years of Training				Totals
	Less than 3	3 but less than 4	4 but less than 6	6 or more	
City Teachers			19	11	30
Non-City Teachers	2	6	98	18	124
Totals	2	6	117	29	154

$Chi^2 = 9.24$; $df = 3$; $.05 > p > .02$

An examination of the contents of Table I revealed that the major difference between the two groups lay in the category of teachers with six or more years of training, and it is here that city teachers far exceed non-city teachers.

Differences Relative to the Number of Physics Courses Taken

Table II compares city teachers and non-city teachers relative to the number of physics courses taken. Since the value of "p" is less than .01, a very significant difference exists between the two groups. City teachers exceed greatly the non-city teachers in the number of physics courses taken at the university level.

TABLE II

CITY TEACHERS COMPARED WITH NON-CITY TEACHERS RELATIVE TO THE NUMBER OF UNIVERSITY-LEVEL PHYSICS COURSES TAKEN

	Number of Physics Courses					Totals
	1 or none	2 or 3	4 or 5	6 or 7	8 or more	
City Teachers	3	8	10	5	4	30
Non-City Teachers	42	55	18	6	3	124
Totals	45	63	28	11	7	154

$Chi^2 = 30.69$; $df = 4$; $p < .01$

TABLE III

CITY TEACHERS COMPARED WITH NON-CITY TEACHERS RELATIVE TO THE NUMBER OF YEARS OF TEACHING EXPERIENCE

	Number of Years of Experience					Totals
	1 to 4	5 to 9	10 to 14	15 to 19	20 or more	
City Teachers	8	2	3	5	12	30
Non-City Teachers	14	28	25	21	36	124
Totals	22	30	28	26	48	154

$Chi^2 = 9.20$; $df = 4$; $.10 > p > .05$

Differences Relative to the Number of Years of Teaching Experience

Table III compares city teachers and non-city teachers with respect to the number of years of teaching experience. The chi-square test shows no significant difference between the two groups at the .10 and .05 levels of confidence. However, the value of chi-square at the .05 level is 9.488, and the value derived from data of Table III is 9.20. This places the value of "p" slightly greater than .05, and would indicate that the difference is close to being significant.

TABLE IV

CITY TEACHERS COMPARED WITH NON-CITY TEACHERS RELATIVE TO SUBJECT-AREA PREFERENCE

	Teaching Preference		Totals
	Physics	Others	
City Teachers	27	3	30
Non-City Teachers	72	52	124
Totals	99	55	154

$Chi^2 = 10.73$; $df = 1$; $p < .01$

Differences Relative to Subject-Area Preference

Table IV shows a comparison between city teachers and non-city teachers with respect to subject-area preference. The chi-square test shows a very significant difference between the two groups. The city teachers show a much greater preference for the teaching of Physics 30 than do the non-city teachers.

The results obtained from Tables I, II, and IV appear to follow a natural sequence. It would be reasonable to assume that teachers who have had more professional

training and more specialized training in physics would indicate a greater preference for teaching in their specialized field. The results of the three tables mentioned above also indicate that the school systems tend to hire teachers who have more training and are more highly specialized in the subject area they teach, (in this case physics), than non-city school systems.

Differences Between City Students and Non-City Students Relative to Their Results in the Physics 30 Final Examinations

Table V shows the difference between city students and non-city students in relation to their results in the Physics 30 final examinations in 1961. Table V is divided into nine horizontal divisions according to the distribution of students' marks in intervals of ten. The vertical divisions divide the students into two groups--city and non-city. The chi-square test shows no significant difference in marks between the two groups of students.

TABLE V

CITY STUDENTS COMPARED WITH NON-CITY STUDENTS RELATIVE TO THEIR RESULTS IN THE PHYSICS 30 EXAMINATIONS

	Scores on Examinations									Totals
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	
City Students	12	31	63	176	211	191	93	36	7	820
Non-City Students	9	16	64	130	199	171	67	18	1	675
Totals	21	47	127	306	410	362	160	54	8	1495

$Chi^2 = 13.053$; $df = 8$; $.20 > p > .10$

II. THE MAJOR PROBLEM

The Relationship of Physics 30 Results to the Four Selected Characteristics of Teachers

The data relating Physics 30 results to the four selected characteristics of teachers were presented in Tables VI to XII. The methods used for analyzing the data were the use of chi-square and the analysis of variance.

The data were first grouped into contingency tables with the teacher characteristics dividing the table vertically and the students' scores on examinations dividing the table horizontally. Initially, the data were tested for significance by the use of chi-square which was reported below each table. The data were then further analyzed by summarizing the data into a table of analysis of variance which indicated the degree of homogeneity of variance. The value of $F_{max.}$ which is the ratio of the largest variance to the smallest variance was recorded below the table and was tested for significance. For further analysis a second table was drawn up to indicate whether there was any significant difference among the means. If the F value equals or exceeded the value of F at the .05 level, then there were significant differences among means.

The Relation to Teachers' Subject-Area Preference

Table VI contains the distribution of Physics 30 scores arranged into two groups. These groups were divided in relation to the teachers' subject-area preference. The chi-square test yielded a "p" value which lay between the .02 and .05 levels of confidence. This indicated that teachers' subject-area preference had a significant positive relationship to students' scores on the Physics 30 final examinations for the year 1960-1961.

TABLE VI

PHYSICS 30 RESULTS OF STUDENTS CLASSIFIED IN RELATION TO TEACHERS' SUBJECT-AREA PREFERENCE

Teachers' Preference	Scores on Examinations									Totals
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	
Physics	15	36	85	245	314	284	134	48	7	1168
Others	6	11	42	61	96	76	28	6	1	327
Totals	21	47	127	306	410	360	162	54	8	1495

$Chi^2 = 15.876$; $df = 8$; $.05 > p > .02$

TABLE VII

DATA FOR ANALYSIS OF VARIANCE: PHYSICS 30 RESULTS CLASSIFIED ACCORDING TO TEACHERS' PREFERENCE

	Physics	Others	Totals
Number of Students	1168.00	327.00	1495
Sum of Scores	54351.00	14201.00	68552
Mean	47.39	43.43	
Variance	222.90	207.07	

Homogeneity of Variance: $F_{max.} = 1.07$ $F_{.01} = 1.00$

Table VII is set up to test the homogeneity of variance between the two means. The F ratio of 1.07 between the two means indicates that there is a difference between the two means. Since the F ratio is greater than one, it indicates that students' scores of teachers who prefer teaching physics are higher than students' scores of teachers who prefer teaching in other fields.

The Relation of the Number of Years of Professional Training of Teachers to the Physics 30 Results on Final Examinations

Table VIII presents the students' Physics 30 examination results compared to the number of years of professional training reported by their teachers.

The chi-square test with twenty-four degrees of freedom yielded a value of "p" greater than .30 but less than .50 levels of confidence. This range of values for "p" was not sufficient to reject the null hypothesis and it could thus be concluded that there was no significant difference between the number of years professional training of teachers and students' scores on Physics 30 examinations.

For further verification of the above mentioned test, an analysis of variance and a summary of analysis of variance were tabulated in Table VIII(a) and Table VIII(b). The value of F in Table VIII(b) being less than one indicated that there was no need to consult the table for F to determine the level of confidence, as a value for F which is less than one indicates that there is no significance between the variables measured. Thus Table VIII(b) corroborated the conclusion drawn from Table VII. An examination of Table VIII(a), however, indicated a difference between the mean for two but less than three years of training and the other means which were quite

TABLE VIII

STUDENTS' PHYSICS 30 RESULTS CLASSIFIED ACCORDING TO THE NUMBER OF YEARS OF PROFESSIONAL TRAINING OF TEACHERS

Years of Professional Training	Scores on Examinations									Totals
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	
Less than 3	0	1	3	2	3	0	1	0	0	10
3 but less than 4	0	2	2	4	12	9	2	1	1	33
4 but less than 6	16	30	87	205	256	243	97	39	4	977
6 or more	5	14	35	95	139	108	62	14	3	475
Totals	21	47	127	306	410	360	162	54	8	1495

$Chi^2 = 24.747$; $df = 24$; $.50 > p > .30$

TABLE VIII(a)

DATA OF ANALYSIS OF VARIANCE: PHYSICS 30 RESULTS CLASSIFIED BY THE NUMBER OF YEARS OF PROFESSIONAL TRAINING OF TEACHERS

	Number of Years of Training				Totals
	2 but less than 3	3 but less than 4	4 but less than 6	6 or more	
Number of Students	10.00	33.00	977.00	475.00	1495
Sum of Scores	356.00	1470.00	44716.00	22010.00	68552
Mean	35.60	45.94	45.82	46.14	
Variance	207.36	214.63	216.97	202.77	

Homogeneity of Variance: $F_{max.} = 1.07$ $F_{.01} = 1.00$

similar. This should indicate some differences. One explanation may be that the student population is very small in this group and therefore would not affect significantly the difference in the whole group.

TABLE VIII(b)

SUMMARY OF ANALYSIS OF VARIANCE
FOR DATA OF TABLE VIII(a)

Sources of Variation	Sum of Squares	Degrees of Freedom	Variance
Among Means	83.17	3	27.72
Within Conditions	296,203.71	1491	198.66

F = .139

Differences Relative to the Number of University-Level Physics Courses Taken by Teachers

Table IX compares the number of university-level physics courses taken by teachers with the students' results on the Physics 30 final examinations. The table is divided vertically into four divisions based on the number of university-level physics courses, and horizontally according to the distribution of students' scores.

A chi-square value of 36.43 with twenty-four degrees of freedom yielded a value of "p" between the .02 and .05 levels of confidence. This range of values of "p" indicated a significant difference between the two variables tested. The number of university-level physics

TABLE IX

PHYSICS 30 RESULTS OF STUDENTS CLASSIFIED ACCORDING TO THE NUMBER OF UNIVERSITY-LEVEL PHYSICS COURSES TAKEN BY TEACHERS

Number of Physics Courses	Scores on Examinations									Totals
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	
None or 1	3	11	32	43	74	66	22	8	0	259
2 or 3	7	15	44	92	140	107	57	13	1	476
4 or 5	6	7	24	103	107	92	43	17	3	402
6 or more	5	14	27	68	89	95	40	16	4	358
Totals	21	47	127	306	410	360	162	54	8	1495

$Chi^2 = 36.431$; $df = 24$; $.05 > p > .02$

courses taken by teachers has a positive relationship to students' scores on final examinations in Physics 30.

For further information on the data from Table IX an analysis of variance (Table XA) and a summary of analysis of variance (Table XB) were performed. The value of F (7.93) from Table X(b) was greater than $F_{.01}$ (3.78) and $F_{.05}$ (2.60). This indicated that there was a significant difference between the means of the two variables tested and that students' scores were affected by the number of university-level physics courses taken by the teachers.

A further study of Table X(a) showed that there was an increase in the means with an increase in the number of university-level physics courses taken by teachers. There was no significant difference between the mean recorded for teachers with two to three university-level courses and those who had four or five university-level courses. Both means have a value of 45.34. The mean for teachers who had six or more courses was greater than the means for any of the other three categories.

Application of the "t" test showed a significant difference between the means of teachers who had none or one university course and those who had six or more courses. Students with teachers having six or more courses scored

higher on the Physics 30 examinations. A significant difference at the .02 level of confidence was also found between the means of teachers with two, three, four and five courses with those who had six or more. There were no significant differences in students' scores for teachers who had from zero to five university-level courses.

TABLE X(a)

DATA ON ANALYSIS OF VARIANCE: PHYSICS 30 EXAMINATION RESULTS CLASSIFIED ACCORDING TO THE NUMBER OF UNIVERSITY-LEVEL PHYSICS COURSES TAKEN BY TEACHERS

	Number of Physics Courses				Totals
	None or 1	2 or 3	4 or 5	6 or more	
Number of Students	259.00	476.00	402.00	358.00	1495
Sum of Scores	11516.00	21583.00	18229.00	17224.00	68552
Means	44.46	45.34	45.34	48.10	
Variance	209.36	206.21	203.35	233.47	

Homogeneity of Variance: $F_{max.} = 1.14$ $F_{.01} = 1.00$

TABLE X(b)

SUMMARY OF ANALYSIS OF VARIANCE:
FOR DATA OF TABLE X(a)

Sources of Variation	Sum of Squares	Degrees of Freedom	Variance
Among Means	4,655.61	3	1551.83
Within Conditions	291,641.27	1491	195.60

$F = 7.93$ $F_{.01} = 3.78$ $F_{.05} = 2.60$

Differences Relative to the Number of Years of Teaching Experience

Table XI compares the number of years of teaching experience of teachers with students' results on Physics 30 examinations. The table is divided vertically into four categories based on the number of years of teaching experience. Horizontally, the table is divided into nine divisions based on students' achievement.

The chi-square test with twenty-four degrees of freedom and a chi-square value of 32.1996 yielded a value of "p" greater than .1 but less than .2. This indicated that there was no significant difference between students' scores and the number of years of teaching experience.

Table XII(a) and Table XII(b) present data for the analysis of variance and the summary of analysis of variance respectively. Table XII(a) and Table XII(b) are found on page 61.

From Table XII(b) an F value of 10.547 indicated a significant difference between the means. Since $F_{.01}$ = 3.78 and $F_{.05}$ = 2.60, the F value indicated that the number of years of teaching experience had a very significant effect on students' scores both at the .01 and .05 levels of confidence. However, the F test for the summary of analysis of variance contradicted the information from the chi-square test. The totally different analysis from Table XI and Table XII(b) may be explained through the use of Table XII(a). An examination of the means of the four divisions of teachers' experience showed that only one of the means differed considerably from the other three. This could probably be the reason for no over all significance from the chi-square test. The mean for the fifteen to nineteen years of teaching experience was considerably higher than the other three means. Use of the "t" test yielded a value of "t" = 4.23 between the means for teachers with ten to fourteen years of experience and teachers with fifteen to nineteen years of experience. A "t" value of 4.23 was very significant both at the .01 and

.05 levels of confidence. Teachers with fifteen to nineteen years of teaching experience produced higher students' scores on Physics 30 examinations than did teachers with ten to fourteen years of teaching experience. Further "t" tests between other pairs of means (other than teachers with fifteen or nineteen years of experience) showed no significant difference between students' scores and the number of years of teaching experience. Teachers with fifteen to nineteen years of teaching experience surpassed all other teachers in producing better students' scores on examinations in Physics 30.

TABLE XI

STUDENTS" PHYSICS 30 RESULTS CLASSIFIED ACCORDING TO THE NUMBER OF YEARS OF TEACHING EXPERIENCE OF TEACHERS

Years of Experience	Scores on Examinations									Totals
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	
1-9	4	13	36	99	123	102	41	14	0	432
10-14	3	5	25	66	74	72	25	10	1	281
15-19	5	10	15	38	63	64	37	16	3	251
20 or more	9	19	51	103	150	122	59	14	4	531
Totals	21	47	127	306	410	360	162	54	8	1495

$Chi^2 = 32.1996$; $df = 24$; $.2 > p > .1$

TABLE XII(a)

DATA OF ANALYSIS OF VARIANCE: STUDENTS' PHYSICS 30 RESULTS CLASSIFIED ACCORDING TO THE NUMBER OF YEARS OF TEACHING EXPERIENCE OF TEACHERS

	Number of Years of Experience				Totals
	1-9	10-14	15-19	20 or more	
Number of Students	432.00	281.00	251.00	531.00	1495
Sum of Scores	19487.00	12489.00	12635.00	23941.00	68552
Mean	45.10	44.44	50.34	45.09	
Variance	184.96	190.99	256.00	219.04	

Homogeneity of Variance: $F_{max.} = 1.38$ $F_{.01} = 1.00$

TABLE XII(b)

SUMMARY OF ANALYSIS OF VARIANCE: FOR DATA OF TABLE XII(a)

Sources of Variation	Sum of Squares	Degrees of Freedom	Variance
Among Means	6,157.05	3	2052.35
Within Conditions	290,139.83	1491	194.59

$F = 10.547$ $F_{.01} = 3.78$

Summary of Differences

The analysis of differences between the four selected characteristics of teachers and the results of their students on the final examinations in Physics 30 showed a significant relationship between (1) subject-area preference and students' scores and (2) the number of university-level courses taken by teachers and students' scores. The number of years of professional training did show differences in students' scores on Physics 30 examinations for teachers who had six or more years of professional training. The teacher characteristic, the number of years of teaching experience, showed that teachers with fourteen to nineteen years of teaching experience produced higher examination results in students of Physics 30 than did teachers with any other range in years of teaching experience. A more detailed summary of findings for both the major and minor problems will be presented in Chapter V of this study.

CHAPTER V

FINDINGS, CONCLUSIONS, AND IMPLICATIONS

This study investigated two minor problems and one major problem. The minor problems investigated were: (1) the comparison of city and non-city teachers with respect to the four measurable characteristics of teachers and (2) the comparison of city students and non-city students with respect to their performance on Physics 30 final examinations. The major problem investigated the competence of Physics 30 teachers for the year 1960-1961 measured in terms of the results of their students on the Physics 30 final examinations for that year. The four measurable characteristics used in this study are: (1) the number of years of teaching experience, (2) the number of years of professional training beyond the Grade XII level, (3) the number of university-level physics courses, and (4) teacher subject field preference.

I. FINDINGS AND CONCLUSIONS

Minor Problems

The first minor problem. Are there any significant differences between city teachers and non-city teachers with respect to the four measurable characteristics of teachers?

Sub-problem one. A comparison of the teachers on the basis of the amount of professional training showed a significant difference between the two groups. This difference was due to the high ratio of city teachers who had six or more years of professional training in comparison with the small number of non-city teachers in the same category. This study supports recent comparative studies by Wasylyk[1] on Mathematics 30, Lindstedt[2] on Grade IX Mathematics, and Eddy[3] on Social Studies IX. All of the above studies report that city teachers surpass non-city teachers in the number of years of professional training. Since these are relatively recent studies, all within the last four years, and find the same results relative to professional training, it could be generalized that city school systems are able to be more selective than non-city schools in hiring teachers with a greater number of years of professional training. This trend may have been the

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[1]E. Wasylyk, "Teacher Characteristics and Grade XII Mathematics Achievement," (Master's thesis, The University of Alberta, Edmonton, 1961.)

[2]S. A. Lindstedt, "Teacher Qualifications and Grade Nine Mathematics Achievement," (Master's thesis, The University of Alberta, Edmonton, Alberta, 1960.)

[3]W. P. Eddy, "Teacher Characteristics and Grade IX Social Studies Achievement," (unpublished Master's thesis, The University of Alberta, 1961.)

result of several factors, some of which are now being remedied. Many rural school systems were not large enough to hire highly specialized and professionally trained teachers. With the formation of large centralized high schools in rural areas, more such teachers will be needed in rural areas. The problem of financing education is also more acute in rural areas. The changes in grant structure with provision made for teachers' grants based on the number of years of professional training may encourage school boards to hire teachers with more professional training.

Sub-problem two. This problem compared the two groups of teachers with respect to the number of university-level physics courses they had taken. The difference between the two groups was found to be highly significant. City teachers had taken more physics courses than non-city teachers. This study agreed with the results of the three studies previously mentioned. An analysis of sub-problems one and two indicated that administrators of non-city school systems had been unable to acquire teachers highly specialized in subject areas, or teachers who have had more years of professional training. It is also possible, however, that teachers have not seen the need for

specialization, as they may have been required to teach a variety of subject matter and felt that they needed a broad education instead of a specialized one. The requirement by the Faculty of Education at the University of Alberta that all teachers choose a major field of interest will eventually enable many schools to be staffed by teachers specialized in their field of study.

Sub-problem three. A comparison of the two groups of teachers on the basis of the number of years of teaching experience showed no significant difference between the two groups measured. The studies by Wasylyk[4] and Eddy[5] have found a significant difference between city teachers and non-city teachers in the number of years of teaching experience, whereas the study by Lindstedt[6] agreed with the present study, showing no significant difference between the groups.

Sub-problem four. This problem is a comparison between city teachers and non-city teachers relative to subject-area preference. A very significant difference

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[4]Wasylyk, loc. cit.

[5]Eddy, loc. cit.

[6]Lindstedt, loc. cit.

was found in which the city teachers showed a much greater preference for the teaching of physics than the non-city teachers. This study was supported by Lindstedt's study[7] where it was also found that city teachers had a greater preference for teaching in their subject field. Wasylyk[8] found no significant difference between the two groups with respect to subject-area preference. Sub-problems two and four are closely related to one another. It appears logical to believe that teachers who have had more university-level courses in a certain field of study would show a preference for teaching in that field, as has happened in this study. This was very likely the reason why non-city teachers did not show a strong preference for teaching physics. If they preferred teaching physics they would probably have taken more courses in that field and vice versa; whereas city teachers had a significantly greater number of university-level physics courses and showed a preference for teaching physics.

The second minor problem. Are there any significant differences between city students and non-city students in relation to their results in the Physics 30 examinations?

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[7]Lindstedt, loc. cit.

[8]Wasylyk, loc. cit.

This study showed no significant difference between the two groups in relation to their scores on the final examinations. In this study the results revealed that city teachers surpassed non-city teachers in three of the four measurable characteristics. These are: (1) the number of years of professional training taken by teachers, (2) the number of university courses taken in the field of physics, and (3) teachers' preference for subject area taught. If these characteristics were expected to produce an increase in students' scores, the scores of city students should then have exceeded those of non-city students. Since there was no significant difference between the two groups in relation to their scores on the final examinations, it could, then, be assumed that these characteristics have had no effect on students' performance. If this were the case, there must then be some other characteristics common to city teachers or non-city teachers which influence students' performance.

The Major Problem

Do differences in the four selected characteristics of physics teachers reflect significant differences in the results of their students in their final examinations in Physics 30?

Subject-Area Preference. In the initial analysis, through the use of the chi-square test from the data in Table I, students whose teachers preferred teaching physics had higher scores on their examinations. A further test of the analysis of variance showed that there was a significant difference between the two means, that a significant difference did exist between the two variables, and that students whose teachers preferred teaching physics had higher scores on examinations than students whose teachers preferred teaching in other fields. The findings of this study support the findings of studies made by Lindstedt[9] on Grade IX Mathematics, by Wasylyk[10] on students and teachers of Mathematics 30, and by Hughes' study[11] on teachers of physics. The four studies which showed a positive relationship between students' marks and teachers' preference for subject-area taught, may have some very important implications to teachers as well as school administrators. It could strongly indicate that teachers should be placed in teaching positions where they are permitted to teach

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[9]Lindstedt, loc. cit.

[10]Wasylyk, loc. cit.

[11]J. M. Hughes, "A Study of Intelligence and of Training of Teachers Factors Conditioning Achievement of Pupils," School Review, 33:197-200, 1925.

courses they prefer teaching. In many instances this is not what happens, especially in non-city school systems where a teacher is expected to perform many teaching duties.

The Number of Years of Professional Training. The results of the chi-square test of Table VIII and the analysis of variance, Table VIII(a) and Table VIII(b), showed that there was no significant difference between the number of years of professional training and students' scores on examinations. The results of this study contradict previous studies by Rogers[12], Wasylyk[13], and Lindstedt[14], who all found a positive relationship between the number of years of professional training by teachers and students' scores on examinations.

Even though the statistical analysis did not show a significant positive relationship between the number of years of professional training and students' scores on their final examinations in Physics 30, an inspection of

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[12]D. C. Rogers, "The Effects of Experience and Training on Improvement in Silent Reading Comprehension," Chicago School Journal, 6:329-331, May, 1924, cited by H. Walker, ed., The Measurement of Teaching Efficiency, New York: The MacMillan Company, 1935, p. 146.

[13]Wasylyk, loc. cit.

[14]Lindstedt, loc. cit.

the means in Table VIII(a) showed that there was a significant difference between the means of teachers who had two but less than three years of training and teachers who had six or more years of professional training. The number of students of teachers who had two but less than three years of training was so small that it did not affect the general analysis to any extent.

The Number of University-Level Physics Courses Taken by Teachers. The initial chi-square test used to analyze the data of Table IX (page 54) did not indicate a highly significant relationship between the number of university-level physics courses taken by teachers and students' scores on final examinations. Since "p" lies between the .02 and .05 levels of confidence, it indicated that there was a significant difference between the two variables. The use of the analysis of variance, however, indicated that there was a high degree of significance between the two variables. Table X(a), page 56, showed that there was an increase in the means with an increase in the number of physics courses taken, especially between teachers who had none or one university-level physics course and teachers who had six or more university-level courses.

This study has found, then, that the amount of preparation in physics by teachers is significantly related to students' examination scores. The best results were obtained by students whose teachers had six or more university-level physics courses.

The findings of this study supported the studies by Davis[15] in chemistry, by Hughes[16] in his study on students of physics, and the study by Wasylyk[17] on students of Mathematics 30. However, it disagreed with the study done by Lindstedt[18] on students of Grade IX Mathematics.

The Number of Years of Teaching Experience. The initial chi-square test on page 61 showed that there was no significant difference between the number of years of teaching experience of teachers and scores obtained by students on examinations. Further examination of the data, through the use of the analysis of variance in Table XII(a), page 61, and Table XII(b), also on page 61, however, showed that a significant difference existed between means, thus

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[15]H. M. Davies, The Use of State High School Examinations as an Instrument of Judging the Work of Teachers, (Teachers College Contribution to Education, No. 611, New York, Columbia University, 1934), p. 101.

[16]Hughes, loc. cit.

[17]Wasylyk, loc. cit.

[18]Lindstedt, loc. cit.

indicating that the number of years of teaching experience has a positive effect on students' scores. The means test for teachers with one to nine years of teaching experience compared to those for teachers with ten to fourteen years of experience showed no significant difference between the results of the two groups. Thus there was no difference in students' scores of teachers who had from one to fourteen years of experience. Students' achievement of teachers with fifteen to nineteen years of teaching experience far surpassed the achievement of students of teachers with one to nine years of experience, ten to fourteen years or twenty or more years of teaching experience. The results of students whose teachers had more than nineteen years of teaching experience showed a negative relationship.

Thus this study showed that the number of years of teaching experience bore a significant relationship to students' scores and that the most effective range of teaching experience lies in the fifteen to nineteen years of experience range. This finding confirms, in general, the findings by Lindstedt[19] on Mathematics IX, by Wasylyk[20]

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[19]Lindstedt, loc. cit.

[20]Wasylyk, loc. cit.

on Mathematics 30, by Rolfe[21], by Moss, Loman and Hunt[22] in chemistry, and by Schunert[23] in Algebra, who all found a significant positive relationship between the number of years of teaching experience of teachers, and students' scores, even though the most effective range differed.

Summary of Findings and Conclusions

This study has compared city teachers with non-city teachers in relation to the four selected measurable characteristics of teachers. It also has investigated Grade XII Physics 30 teachers in Alberta schools for the school year 1960-1961 and reports the following findings:

1. There were significant differences between city teachers and non-city teachers. City teachers greatly surpassed non-city teachers in the number of university-level courses taken in the field of physics and in their preference for teaching physics. The difference between the two groups was also significant in the amount of

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[21]J. F. Rolfe, "The Measurement of Teaching Ability: Study No. 2," Journal of Experimental Education, 14:64, 1945.

[22]F. A. Moss, W. M. Loman, and T. Hunt, "Impersonal Measurement of Teaching," Educational Record, 10:40-50, 1929.

[23]J. Schunert, "The Association of Mathematical Achievement with Certain Factors Resident in the Teacher, in the Teaching, and in the Pupil, and in the School," Journal of Experimental Education, 19:233, March, 1951.

professional training taken by teachers. No significant difference was found between the two groups when compared on the basis of the number of years of teaching experience.

2. There was no significant difference in performance between students of city teachers and students of non-city teachers in their scores on the final examinations in Physics 30 for the school year 1960-1961.

3. There was a very significant positive relationship between students' scores in the June 1961 final examinations in Physics 30 and three of the characteristics of teachers. The three characteristics were: (1) the number of years of teaching experience, (2) teacher preference in the subject field, and (3) the number of university physics courses held by the teacher.

4. A significant difference was found between students' scores and the number of years of professional training of teachers, especially when teachers had six or more years of professional training.

This study used the same four selected characteristics to measure teacher competence as the studies by Lindstedt[24] on Mathematics IX, by Wasylyk[25], on Mathematics

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[24]Lindstedt, loc. cit.

[25]Wasylyk, loc. cit.

[26]Eddy, loc. cit.

and by Eddy on Social Studies IX[26]. The writer would like to establish some common relationships among the four studies wherever such relationships exist. In the two minor problems under study, the four studies showed that city teachers differed significantly from non-city teachers in the number of university-level courses held by teachers. City teachers surpassed the non-city teachers. There was no agreement on the other three characteristics used.

The findings in the major problem showed a significant relationship between students' marks on final examinations and three of the teacher characteristics used. The three characteristics which produced better student results and were common to the four studies were: (1) subject-area preference, (2) the number of years of teaching experience, and (3) the number of years of professional training. There was no clear-cut agreement on the other characteristic among the four studies.

II. IMPLICATIONS OF THE STUDY

This study has several important implications to teachers, to teacher-training institutions, and to school

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[26]Eddy, loc. cit.

administrators with respect to the characteristics of teachers studied.

Implications to Teachers

This study suggests that teachers should choose a specialized field in education and concentrate on taking as many university courses as possible in their chosen field. This statement takes into consideration teachers' subject-area preference, and the number of university-level courses as well as the number of years of professional training taken by teachers. The fact that the other three studies referred to show a strong relationship between subject-area preference and students' marks substantiates the implications of this study not only to teachers of physics but it could apply to teachers generally, since they are concerned with three other subject fields. The agreement between this study and the study by Wasylyk[27] on the significance of university-level courses to students' achievement on examinations and the disagreement by Lindstedt[28] on the Grade IX study may be an indication that teachers should have more specialized training as they move towards the teaching of higher grades in the high school. Teachers

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[27] Wasylyk, loc. cit.

[28] Lindstedt, loc. cit.

should also be aware that the number of years of teaching experience will have an effect on students' marks in Grade XII Physics 30 examinations, but that the effectiveness decreases after twenty or more years of teaching experience.

Implications to Teacher Training Institutions

The results of this study may have significant implications to teacher-training institutions. This study implies that teachers should be permitted to choose a major area of study and pursue this by taking as many courses as possible related to their field of preference. This study further implies that a training program for teachers of physics should have an extensive background of content courses in physics. Since the same results with respect to teacher preference and to the number of university-level courses were found in both this and Wasylyk's study, it may lead to a generalization that this type of training should be offered to teachers who are enroled in secondary education. The writer realized that these recommendations cannot be made on the basis of two studies, but future studies of this type could be encouraged by institutions concerned with research.

Since teaching experience has a very significant effect on students' performance, consideration should be

given this characteristic by teacher-training institutions. It would be difficult to make a direct recommendation from this study, as it reveals that best results on students' examinations are derived from students whose teachers have from fifteen to nineteen years of teaching experience. The majority of studies reviewed show a positive relationship between teaching experience and students' marks, but do not agree on the range that produces best results. Until this is determined, the implication to teacher-training institutions may be that the present practice teaching courses should be increased in length, or internship programs as recommended by the Alberta Royal Commission on Education be introduced.[29]

Implications to Administrators

This study reveals that non-city teachers were teaching in subject areas for which they showed no preference. Since this study has shown that teachers produce best results in students' examination scores when they teach courses for which they show a preference, administrators should give more consideration to the placement of teachers in their school systems. Teacher

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[29]Report of the Royal Commission on Education. (Edmonton: Government of Alberta, The Queen's Printer, 1959), p. 187.

should be hired to fill a specific teaching position, and they should be adequately prepared by a background of university-level courses in the particular position the teacher is expected to fill. Teacher placement should be carefully considered by the superintendents and principals of their respective school systems if the best use of their teachers is to be made.

These, and other implications could be drawn from studies of this type, but as yet, not enough studies have been conducted on teacher characteristics and their effects on scores in students' final examinations to draw any definite conclusions.

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APPENDICES

APPENDIX A

QUESTIONNAIRE SENT TO ALBERTA SCHOOL PRINCIPALS REGARDING PHYSICS 30 TEACHERS FOR THE SCHOOL TERM 1960-1961

The teachers' questionnaire was designed primarily to furnish information on the four measurable characteristics of teachers. In addition to these, a question to determine whether the teachers came from a city, or a non-city school system was included. This information was needed to establish the relationship between characteristics of teachers and students' marks on the final examinations in Physics 30. Below is a sample of the questionnaire sent to Alberta school principals.

I. In what type of administrative unit is your school located? (Check one)

a. _____ city b. _____ non-city

II. What is the extent of your total academic and professional preparation beyond high school? (check one)

a. _____ less than two years

b. _____ 2 years but less than three years

c. _____ 3 years but less than four years

d. _____ 4 years but less than six years

e. _____ 6 years or more

III. Counting the school year 1960-1961, what is the total number of years of full time teaching experience you have had? (check one)

a. _____ 1 to 4 years b. _____ 5 to 9 years

c. _____ 10 to 14 years d. _____ 15 to 20 years

IV. How many university content courses have you completed in the field of physics? (circle one)

none 1 2 3 4 5 6 7 8 more

V. In which of the following subject areas would you prefer to teach? (check one)

a. _____ physics b. _____ other fields

VI. Name of School _____

VII. Physics Teacher _____

VIII. Principal _____

APPENDIX B

TEST OF REPRESENTATIVENESS OF SAMPLES

The three groups tested for representativeness are: (1) total sample of Physics 30 students (Table XIII), (2) sample of Physics 30 students of city schools (Table XIV), and (3) sample of Physics 30 students of non-city schools, (Table XV). The probability value "p" in each case is greater than .05, thus indicating that there is no significant difference between the sample population and the expected distribution.

TEST OF REPRESENTATIVENESS FOR TOTAL SAMPLE OF STUDENTS

	Scores on Examinations										Totals
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	
fo	6	21	68	99	347	404	280	181	73	16	1495
fe	7.6	28.5	85	104	363	397	268	160	66	15.9	1495

$Chi^2 = 10.83$; $df = 9$; $.30 > p > .20$

TEST OF REPRESENTATIVENESS OF
SAMPLE OF CITY STUDENTS

Scores on Examinations

	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	Totals
fo	3	12.0	35.0	51.0	167	219	170	98.0	53	12.0	820
fe	4	16.5	46.5	55.6	185	215	156	86.6	43	11.8	820

$Chi^2 = 11.47$; df = 9; $.30 > p > .20$

TEST OF REPRESENTATIVENESS OF
SAMPLE OF NON-CITY STUDENTS

Scores on Examinations

	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	Totals
fo	3.0	9	33.0	48	180.0	185.0	110	83.0	20.0	4	675
fe	3.4	12	38.5	49	184.3	183.6	108	74.6	18.9	3	675

$Chi^2 = 3.1$; df = 9; $p > .95$

APPENDIX C

TRANSFORMATION OF PHYSICS 30 SCORES

A correlation table of the students' scores on the Physics 30 final examinations and their scores on the Grade IX mental ability test is presented below. The data are used for transforming the scores.

Method

The proof for the method used for obtaining the regression formula used to transpose examination scores to new scores when mental ability was taken into consideration was the one used by Wasylyk in 1961.[1] The equation used for deriving the new score was: $Z = Y + 20.66 - .38X$ where Z was the new score, Y the score on the Physics 30 examinations and X the percentile score. The regression equation $Z = Y + 20.66 - .38X$ was derived in the following manner.

$$Z = Y + (\overline{Y} - Y^1)$$

$$Y^1 = \overline{Y} + r. \frac{SDy}{SDx} (X - \overline{X})$$

$$= 53.53 + .433 \times \frac{15.86}{18.16} (X - 54.37)$$

$$= 32.87 + .38X$$

$$Z = Y + 53.34 - 32.87 - .38X$$

$$= Y + 20.66 - .38X$$

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[1] Wasylyk, op. cit., pp. 93-97.

To illustrate the use of the formula, students with physics scores in the interval 71-75 and mental ability scores in the interval 41-45 were given a physics score of 77. The score was calculated in the following manner:

$$Z = 73 + 20.66 - .38(43) = 77.32$$

To the nearest whole number, a score of 77 was given to the students in that interval.

CORRELATION TABLE OF STUDENTS' PHYSICS SCORES AND MENTAL ABILITY TEST

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Scores on Mental Ability Test (X)

MARKS ON PHYSICS EXAMINATIONS (Y)	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96-100	Totals
96-100																				5	5
91-95														1					1	9	11
86-90																2	1	1	4	10	18
81-85												1	1		4	3	5	5	9	27	55
76-80															2	5	5	7	17	29	65
71-75									1	1	1	1	5	5	4	7	7	17	17	50	116
66-70	1					1				1		2	3	4	4	10	11	18	26	51	132
61-65				1		1			2			1	3	3	7	16	26	22	26	46	148
56-60				1		2	2		5	2	5	8	5	11	24	16	17	34	45	48	225
51-55					1	1	4	1	5	9	3	11	5	11	16	8	31	24	28	21	179
46-50						1	1	2	7	3	6	12	4	6	13	17	18	20	11	11	132
41-45			2	2	1	1	4		14	5	9	12	11	22	27	23	28	25	10	19	215
36-40				1	1	1	2		1	2	4	4	3	2	6	3	7	4	7	2	50
31-35			1				1		2	3	4	6	2	4	4	1	7	7	3	4	49
26-30				1			2	3		1	1	3	4	2	3	4	4	2		1	,31
21-25	1			1		1		3	5	4	1	4	3	4		4	2	2		2	37
16-20										1				1	2	3	2		1		10
11-15				2				1			1	1	2		3			1			11
6-10										1	1		1	1	1			1			6
Totals	2		3	9	3	9	16	10	42	33	36	66	52	67	120	122	171	190	205	329	1495

$\overline{Y}$ = 54.534 N = 1495 $\overline{X}$ = 54.369 r_m = .433 Z = Y+20.66 - .38X SD_y = 15.86 SD_x = 18.16

APPENDIX D

FORM A CARD

The Form A card was sent to school principals at the beginning of the school term to provide the Department of Education with detailed information on the organization of the school for the particular school term. The Form A card was divided into three sections. Section one dealt with general information on the school system and also included a sub-section which dealt with special circumstances pertaining to the school. Section two provided information on teachers pertaining to subjects taught, the number of credits taught, and the type of certificate held by the teacher. Section three gave a list of courses offered, the number of students enroled in each course, and the teacher responsible for giving instruction in each course.

APPENDIX E

ASSUMPTIONS UNDERLYING THE ANALYSIS OF VARIANCE

Underlying the application of the analysis of variance are several assumptions. The more the data in an investigation depart from the strict fulfillment of the assumptions, the more likely is the investigator to reach erroneous conclusions. It may be difficult to satisfy all assumptions, and it is doubtful whether the failure is sufficiently great to invalidate application of this technique. Recent evidence suggests that the limits of tolerance within which the assumptions must be approximated are wider than originally thought.

One of the major assumptions in the analysis of variance is that the observations within each category must be random samples.

Another major assumption is that the variances within the sub-groups are homogeneous, that is, they are data from a single normally distributed population.

It is assumed that the best estimate of the population variance can be obtained from the pooled variances among the sub-groups. If this condition is true, each individual sub-group variance should yield the same evidence about the population variance. It is becoming

more apparent that the analysis of variance technique is sufficiently satisfactory even when there is considerable departure from the strict fulfillment of the assumptions.[1]

In this study the conditions of the first major assumption have been met by the method used to classify the physics scores. In this case the scores assigned to each category can not affect the scores in any other category.

The assumption dealing with the normally distributed population is reasonably satisfied as can be seen from Table V which classifies city and non-city students relative to Physics 30 marks. The population appears to be well distributed about the mean (53.534). There does, however, appear to be a slight skewness to the left. As mentioned above, it is doubtful whether a slight variation from the normal would invalidate the application of the analysis of variance.

The assumption concerning homogeneity of variance was also a point of consideration in this study. To test the homogeneity of variance, the ratio of the largest

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[1]J. E. Wert, E. O. Neidt, and J. S. Ahmann, Statistical Methods in Education and Psychological Research, (New York: Appleton-Century-Crofts In., 1954), pp. 183-184.

variance to the smallest variance is found. This ratio, $F_{max.}$, is then tested for significance by the F test. The value of F required for significance is 1.00. In this study the $F_{max.}$ ratios were 1.07, 1.07, 1.14, and 1.38. None of the ratios in this study could be considered as extreme.